LETS LEVITATE

The Superconductor Hobby Club
1915 Zachary Drive, Salt Lake City Utah 84116
801-596-3592

Volume 4 Issue 1 February 1990

Fusion Royale-2

Neale Neelameggham and K. Ganeshan

In the December 89 issue of LETS LEVITATE, SHC predicted that sustained economic fusion will happen in the following experiment designed to simulate the main effects in the sun. "Carbon-proton fusion cycle which can be simulated by comprehending Haber synthesis in an ordinary water high-voltage (if necessary up to corona levels) direct current electrolysis (initiating period of very short duration) using a nitrate or ammonium salt for initial conductivity boost, and providing the nitrogen nucleus."

Several readers wanted to know the basis of our prediction; in response to these requests, the following note is presented below. The equations given below are excerpted from "**Nuclear Chemistry**" by Bernard G. Harvey, page 111 (equations shown under the title, Nuclear Astrophysics, Carbon-nitrogen-oxygen cycle for catalytic synthesis of He^4 from hydrogen).

(a) ${}_6C^{12} + {}_1H^1 = {}_7N^{13} + \gamma$
(b) ${}_7N^{13} = {}_6C^{13} + \beta^+$
(positron decay)
(c) ${}_6C^{13} + {}_1H^1 = {}_7N^{14} + \gamma$
(d) ${}_7N^{14} + {}_1H^1 = {}_8O^{15} + \gamma$
(e) ${}_8O^{15} = {}_7N^{15} + \beta^+$
(positron decay)
(f) ${}_7N^{15} + {}_1H^1 = {}_2He^4 + {}_6C^{12}$

Now, we ask the readers, why the above reaction can not be accommodated by aqueous electrolysis? After all proton generation, is the backbone of aqueous electrolysis. Use Carbon cathodes. Nothing unusual. Our friends around the globe, making carbon or graphite electrodes would love to make a few bucks... they are at least, as smart as the lawyers, who do...

To those readers wondering why SHC was talking about Haber Synthesis... Haber said about eighty plus years ago, that corona voltages struck during lightning causes atmospheric nitrogen to combine with hydrogen from ionization of water vapor helps the formation of ammonia. But, we at the SHC say that an extension of the same can cause the energetic oxygen formation as shown by equation (d).

The bottom line, in all these reactions is the hi-voltage dc initiation; using, carbon (graphite) cathodes, introduce nitrogen/ hydrogen/ oxygen species such as nitrate/ ammonia; zap them with hi-voltage dc; bingo, you are ready to start the solar fusion at room temperature.

Peroxides & Superconductivity

During 1988, SHC published an article called "Peroxvite Theory of Superconductivity". This article explained why peroxide ions in combination with oxide ions are instrumental in providing the superconducting property to the YBCO and similar oxide high-T_c compounds.

It is noteworthy that similar theorizing has been arrived at by N.A.Gokcen (USBM, Albany, Ore.) and C.H.Hsu (DuPont, Fibers Department, Wilmington, Del.). Their paper titled 'The Nature of Oxygen in Oxide Superconductors' gives a statistical thermodynamic equation for the dissolution of gaseous oxygen in YBCO. This paper will be presented in the TMS Annual Meeting, Anaheim, California, during the week of February 19, 1990.

> The abstract of this paper says that, *'analyses of existing data suggest that (a) a layered-type crystal structure is essential and (b) at least one element capable of forming a peroxide or superoxide is necessary to the -O-O- chains. The presence of copper is effective but it must be tentatively regarded as nonessential if new superconductors with high critical temperatures were to be discovered. A possible route for this purpose might rest on an analysis of the d-orbital of the transition elements.'*

J.M.Honig, Purdue University, will be discussing about Rare Earth Nickelates - A New Class of Superconductors, in the same meeting. Some papers on this subject have already appeared in *J. Solid State Chemistry*, and in *Solid State Communication* during 1989.

SC Forum

The 1990 Annual AIME/TMS Meeting, Anaheim (February 19-22) will see the presentation of some 79 papers on high-T_c superconductors during 12 different sessions. Major session titles include Hume-Rothary memorial symposium on high-T_c metallic oxides, fabrication, thermodynamics of superconductors, bulk synthesis/oxygen dissolution, thin films, melt texturing/substitution techniques, deformation/mechanical properties of superconducting oxides, wire/tape/filament formation of superconducting oxides, and magnetism/critical temperature interplay of superconductors.

NYSIS (330 Bonner Hall, SUNY at Buffalo, Buffalo, NY 14260) announces the Call for Papers for its forthcoming Fourth Annual Conference on Superconductivity and Applications, to be held during 18-20 September 1990. Abstracts are due on 15 April 1990 (4 copies) and can be mailed to: Conference Chairs, NYSIS, 330 Bonner Hall, Buffalo.

SPIE - The International Society for Optical Engineering will be holding technical conferences on Advances in Semiconductors and Superconductors: Physics Toward Device Applications during 17-21 March 1990, in San Diego, California. The Superconductor conference will have a session on Film Fabrication Techniques and Properties and a session on Junctions, SQUIDs, and FETs. One of the papers 'Electrochemical deposition of high T_c superconducting thin films has been authored by scientists from US, Brazil and China, indicating multi-national cooperation in high-tech research.

The 1990 Spring Meeting of MRS during April 16-20, 1990 in San Francisco will include a short course program on the Fabrication, Characterization and Applications of High Temperature Superconducting Materials. The Instructors are T. P. Orlando and R.E. Schwall. The course fee is $510. (April 16-17). Call 412-367-3003, if interested in the course.

SCUIPS

During January 1990, an International Conference on Superconductivity was held in Bangalore, India. The following two discussions are noteworthy: preparation of superconducting cables by shock-wave synthesis (Allied Signals, NJ, US), and the fabrication of electromagnets by alternating the superconducting material through cold-rolling and sintering (Japan). Other discussions included who is spending what on T_c research.

Interesting applications of superconductors in the field of Infra-red and Microwave Devices will be discussed in the SPIE Conference 1292, during April 16-20 in Orlando, Florida. Conference registration fees $370. Those interested contact SPIE, PO Box 10, Bellingham, WA 98277-0010. (Tel:206-676-3290). The conference 1292 proceedings for non-members is $48 (in US) or $55 (from other countries). This symposium will have a total of 26 papers. NASA/Lewis Research Center is one of the leaders in this novel high-T_c compounds-application field.

Those interested in finding "Is $Y_1Ba_2Cu_3O_7$ Stiff or Soft?" are referred to the Journal of Materials Research, February 1990 issue.

Center for Advanced Ceramic Technology, New York State College of Ceramics, Alfred University, will be offering a Short Course on Ceramic Superconductors (Course Number 378), during June 4-5, 1990. The instructors will be Dr. A. N. Cormack, Dr. R.L. Snyder and Dr. V. Amarakoon. The course fee is $595. Those interested should contact Mrs. Coral M. Link, Director, Technology Transfer, Alfred University, Alfred, NY 14802. (or call Mrs. Marlene Wightman, (607)871-2486).

The IISSC show, during March 14-16, 1990, will exhibit several cryogenic engineering products. Among them will be the exhibit of a new superinsulation designed for NMR and lo-T_c superconducting magnets. The product NRC-2 500, being introduced by Metallized Products, Inc., has a 500 angstrom aluminum deposited on the insulating substrate. Contact David Koopman, MPI, 37 East Street, Winchester, MA 01890.

Superczynski on SC Electric Drives

(Excerpts from Cold Facts, Feb 1990).

Michael J. Superczynski, the head of the Electrical Machinery Technology Branch at the U.S. Navy's David Taylor Research Center in Annapolis, MD., gave a talk on "Superconductive Electric Drive on Ships" during the November 1989 meeting of CEBAF/SURA, Hampton Roads Chapter.

His speech highlighted the following, (as abstracted from the article by J.P. Kelley, Hampton Roads Chapter Chairman): 'Using superconducting wire for motor and generator windings offers a large savings in size and weight. Projections for a superconductive DC motor producing 40,000 H.P. at 180 RPM indicate the weight reduction factors of up to 65000 lbs and a space reduction factor of 30 to 50%, when compared to conventional liquid and air cooled AC motors. These superconductive motors apply the principles of Homo-polar Motors proposed by Michael Faraday in 1847. Improvements of the SC motor design requires good vibration isolation in the cryogenic system, which is not easily accomplished.'

Lo-γ

Read from a cartoon by Bagey in Salt Lake Tribune, January 15, 1990. -- "The Last Thing You Want To Hear On Your Next Trip To the Hospital: 'Oh, What the heck ... Get me a Jarvik 7 with a Cold Fusion Power Unit' ".

In January more US Labs-- Oak Ridge, Los Alamos and others indicated tritium production in their cold-fusion cells ....improving the authenticity of the claims from Utah.

Dr. Fritz Will, took over as the director of the National Cold Fusion Institute, Salt Lake City, Utah. His initial goals include:-- to direct the Institute in developing duplicatability of the excess heat generation and demonstrating the ability to control this phenomenon at will. His press releases indicate that the efforts in India and Japan in this filed are more than what is happening here in the US.

The National Cold Fusion Institute will be holding a conference during March 28-31, 1990. This is a conference by invitation only (from the Institute). Recognized international scientists in this field are expected speakers.

SHC has additional collection of University Electronic Network (Arpanet/Bitnet) discussions on Cold NF, including a reasonable bibliography on the subject collected by BYU group. Copies available on request.

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In response to the question about Dilithium

Ray Ramadorai

Gene Rodenbery created Star Trek as a fictional T.V. Show. It has developed into an obsession for some people. The latest development is a new show called "Star Trek, The next Generation" which is currently running a series.

Although Dilithium does not power the star ship Enterprise, but it does focus the antimatter/matter engines that do power the Enterprise. To be functional, the crystals must be organized in a precise pattern or they will not focus the output from the anti/matter engines.

Dilithium is a rare fictional mineral that in its crystalline form is harder than any known substance. It is so hard that it exceeds physical laws for strength.

Dilithium has many interesting characteristics that make it so valuable. The reason for this strength is the fact that it exists in four dimensions. Because of this feature it is very hard to cut or break. To break it I would have to hit it hard today, yesterday, a week from tomorrow etc... To cut Dilithium, high output lasers must be used on it for many days before it will break.

SCUIPS

Dr. P.K. Iyengar, Chairman, BARC, India, made a visit to the Superconductor Hobby Club during his recent trip to Salt Lake City attending the First Annual Conference on Cold Fusion. Club members had interesting discussions with him and with Dr. Srinivasan (BARC) particularly on articles on Superconductivity and Cold Fusion published last year in Let's Levitate.

Dr. J. Lackey et al, Georgia Institute of Technology, recently announced their technique of CVD fabrication of extremely thin-film superconductors on flexible metal or ceramic filaments. Their technique is capable of producing film thicknesses of 50 to 200 microns per hour. They are planning to produce a prototype superconducting magnet in conjunction with American Magnetics, Inc of Oak Ridge, TN. (CEP, April 1990, page 24). (Contact: Ginger Pinholster or John Toon, 404-894-3444)

Chemical Engineering and the Development of Hot Superconductors by Dr. R. Kumar, Indian Institute of Science, India is a special article reprint in Chemical Engineering Progress, April 1990. He notes that 'A major problem concerned possible low current densities (around 1000 A/cm^2) in bulk superconductors, but a major breakthrough occurred in 1989 when J_c values of 10^5 A/cm^2 were achieved by making

$YBa_2Cu_4O_8$ and then heating it rapidly to 920°C to obtain $YBa_2Cu_3O_7$. Because this was reported only recently, it may have to be verified by other groups.

World congress on Superconductivity announces its forth coming '2nd World Congress on Superconductivity September 10-13, 1990, Houston, Texas.' Those interested contact Calvin Burnham (Tel: 713-895-2500), P.O. Box 27805, Houston, Texas 77227-7805 USA.

A report on the new Detwinning Process for YBCO crystals can be obtained by writing to W.Gayle, NIST, A153 Materials Bldg., Gaithersberg, MD 20899.

AKZO Chemicals Inc. (Chicago, IL) has come up with a solution deposition of YBCO using alkoxide precursors (Sean S Clancy, 312-906-7654)

'Anyons' are in high T_c SC's - possibilities of these low-energy quasi particles (two dimensional quanta) in high T_c copper oxides was one of the highlights of American Physical Society Conference in March.

Supercon Inc, Shrewsbury, MA 01545 is expanding its R&D in both high and low temperature superconducting material and applications.

Journal of materials Research April 1990 has nine articles on Superconductivity - including the ones on preparing $YBa_2Cu_3O_{7-x}$ by the metal alkoxide method and on flexible stainless steel foil as a substrate for superconducting YBCO films. For review copies contact David Sours, MRS, 9800 McKnight Road, Pittsburgh, PA 15237.

MRS has established two major new awards for materials Research: 'The outstanding Young Investigator Award' and 'The MRS Medal' - a hall mark recognizing a recent major scientific or technical achievement or breakthrough in a materials related area. Nominations for these two awards and Von Hippel Award are sought by MRS. For details contact David Sours (412-367-3003).

Cold Fusion Conference

The first annual Conference on Cold Fusion was held between March 28 and 31, 1990 at the National Cold Fusion Institute. About 45 papers were presented along with two panel discussions (Thermal Phenomena and Nuclear Phenomena). The participants included Dr. J. Schwinger, Nobel Laureate and scientists from India, Taiwan and Italy, besides the well known cold fusion scientists Pons, Fleischmann, Hawkins, Huggins, Bockris, Jones, Wolf, Guruswami, Wadsworth and several others. Dr. F.G. Will, Director of the Institute opened the conference and the meeting was honored by a speech from the Governor of Utah.

Highlights of the conference included several speakers verifying 'Tritium Production' in their Cold Fusion cells (10 to 25 percent probability) although none were correlated with excess heat production, excerpts are shown below:

.......'excess heat... observed from 4 electrodes out of 28, tritium in 11 out of 47'... (J.O'M Bockris, Texas A&M).

.......'Tritium has been produced in ..10% of the cells studied, but there is, as yet, no pattern of behavior that would make the effect predictable. (E. Storms & C. Talcott, LANL) --. Cathodes tested were palladium and its alloys with Li, C, S, B and Be ..... anode materials were platinum, nickel and stainless steel'......

.......'Enhancement of tritium was found in the cell with 0.5mm Pd wire in a cell with O.1M LiOD and Ni anode. (The enhancement factor of tritium was 40 when comparing the electrolyte sample with original D_2O. Lithium was found to penetrate 200 nm into Pd bulk'... (R. Adzic et al, Case Western U).

There were a few papers on excess heat generation and calorimetry.

Dr. P.K. Iyengar, Chairman, Bhabha Atomic Energy Research Center, India presented one of the most positive 'Overview of BARC studies in Cold Fusion'. ....'it is tritium which is the primary product of cold fusion reactions, with the neutron to tritium yield ratio being 10^{-8} ...Once initiated, the cells produced approximately 10^5 n/cm^2 and a microcurie of tritium/cm^2 of cathode surface area (D/Pd cell) .... over a dozen "aged" (8 to 18 years old) deuterated titanium targets ... have been found to contain unexpectedly high tritium levels (approx. 100 micro curie) .... Cold fusion over the years appears to be a plausible explanation. All in all BARC studies have confirmed the occurrence of nuclear fusion reactions at ambient temperatures in deuterium loaded Pd and Ti samples.'

Another interesting observation was made by Debra Rolison et al, of Naval Research Center 'Two samples (of Pd) electrolyzed in D_2O exhibited greater than 20% enrichments in m/z 106 (Pd isotope with mass 106 intensity and diminution in m/z 105 intensity. This result is provocative because of the implication that ${}^{105}_{46}Pd$ obtained a neutron to generate ${}^{106}_{46}Pd$......'

Besides the above noteworthy experimental results there were several theoretical presentations.

Lo-γ

Seen in I^{2}R calendar March 1990 - 'Ajax Science Fair' Troop 16 Project is Cold Fusion Fund Raiser project - sponsored by Ajax Chemical Company 'to help buy Palladium' with Fusion - Lucky Breaks, Diffusion - Tough Breaks, Infusion - Good Breaks, Confusion - bad Breaks and Fuses - 4 wheel Breaks - Thanks to the cartoon by Eric Frazer, et al Australia.

Fusion Info Center - "an independent corporation not affiliated with the University of Utah" (as noted in their letter-head) has been publishing a news letter 'Fusion Facts' since July 1989. Those interested can contact them at 801-583-6232. (Annual Subscription $260). There are other related newsletters in this field.

Fusion Asia, C-9 Nizamuddin East, New Delhi 11001, India ($40 for 4 issues).

Fusion Technology, 555 N Kensington Ave, LeGrange Park, IL 60525 ($310 for 2 Vol + supplement)

Technical Notes on Cold Fusion (besides hot) - reviewed articles are published in Fusion Technology. Manuscripts shall be submitted to George H Miley, Editor, Fusion Technology, Fusion Studies Laboratory, University of Illinois, 103 S Goodwin Ave., Urbana IL 61801. Tel: 217-333-3772.

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Superconducting Devices -- A Book Review

The recently published book 'Superconducting Devices' by Academic Press Inc. is a welcome change to practicing technologists. This collection of articles written by several US, Japanese and Russian Engineers and Scientists is edited by Steven T. Ruggiero (Dept. of Physics, U of Notre Dame, Indiana) and David A. Rudman (Dept. of Material Science & Engineering, MIT).

This compilation gives equal treatment to micro-devices made of both high and low T_c superconductors, pointing out the pros and cons of applying each type of material in the superconducting devices. The major topics covered in the book are ----- SQUIDS, Computing, Josephson Arrays as High Frequency Sources, Quasi-particle Mixers and Detectors, Digital Signal Processing, Wideband Analog Signal Processing, Molecular Beam Epitaxy Growth of Superconducting Materials, Three Terminal Devices and Artificial Tunnel Barriers.

Theoretical basis for practical applications are noted along the way in each chapter - which should satisfy the theoretician as well as the pragmatist. Some notable excerpts from the book are given here:

The drastic decrease of the refrigeration costs, by using high T_c SC's, can justify some applications of superconductors, which were well recognized but rarely used earlier. A very characteristic example of these is the shielding of closed volumes from external electromagnetic field (EMF) interferences.

Due to the Meissner effect, a virtually perfect shielding at all frequencies from dc to at least ultraviolet can be provided by even a thin superconducting shell, ... [K.K.Likharev, et al, Moscow].

One potential application of a high-T_c SQUID is as a geophysical magnetometer. The likely impact of high-T_c SQUIDS on the more demanding applications such as neuromagnetism is much smaller, however, at least for the near future. In this chapter, we have tried to give an overview of the current status of *dc* and *rf* SQUIDS. [John Clarke, U of Cal., Berkeley].

Hisao Hayakawa's (Nagayo U) article on Computing, mainly discusses the history of applying low T_c SC's in computing. It points out basics of Josephson Switching Gates and how they can be modified to act as Logic Gates by magnetically coupling Josephson Junctions or direct coupling with resistors in a bridge or by a combination of both. Simple discussion of alternate memory cells using SC's and examples of constructing micro-processor circuits are quite worthwhile reading for computer architects.

James Lukens (SUNY, Stoneybrook) covers the applications of Josephson Junction arrays in generating low power high frequency (up to tens of TeraHertz) sources that are more compact than '...bulky and power hungry (solid state) sources as carcinotrons and CO_2 lasers, which operate in some parts of the submillimeter range'.

'Josephson Junctions are natural voltage controlled oscillators,.... As the Josephson Junction equations imply, the average frequency of supercurrent oscillation ν_o, which we call the Josephson frequency, in a junction is related to the dc component $\mathbb{V}$' of the voltage across the junction only through fundamental constants,

$$\mathbb{V}' = [h/2e]\nu_o$$

where e is the charge on the electron, h is Planck's constant, so $2e/h$ = 483 GHz/mvolt $\mathbb{V}'$. In more recent work, including successful attempts to obtain increased power from arrays of junctions, the junctions are simply treated as oscillators,.....'

Signal Processing A/D converters and Detector technology are covered in 3 chapters with a wealth of bibliography and discussions. The chapter on Molecular Beam Epitaxy Growth of Superconducting Materials [A.I.Braginski & J.Talvacchio, Westinghouse S&T Center, Pittsburgh] compares fabrication parameter of both low and high T_c SC's and outlines suitable substrates for use.

The chapter by Kleinsasser and Gallagher [IBM, T.J.Watson Res. Center] discusses the subject of three-terminal superconducting devices. 'Without a three-terminal transistor-like device, superconducting electronics will undoubtedly remain relegated to specialized niches.' Introduction to Hybrid Superconductor-Semiconductor devices, and other magnetic devices is provided, indicating the need for additional work in this area in developing a truly successful three-terminal SC devices.

The final chapter by S.T. Ruggiero, reviews the work in the field of Artificial Tunnel Barriers -- dielectric barrier between two superconductors in creating the Junctions -- over the last 20 years.

In conclusion, it is felt that, this book can be used as graduate level text book by departments of Electronics, Material Science or Physics, if there is a course on the subject 'Superconductor Applications' which will form some of the basis of twenty-first century technology. In addition, this book is a valuable asset to the reference or desk library of all microelectronic hobbyists, architects and technologists.

Scuips

David Sours or Mary Phelps (MRS 9800 McKnight Road, Pittsburgh, PA 15237, Tel 412 367 3012) can be contacted to get details on recent publications by the Materials Research Society.

The following articles on Superconductivity can be found in the May and June issues of the Journal of Materials Research.

- Growth Twins in $Bi_2Ca_2Sr_2Cu_2O_8$ SC single crystals

- Grain boundary dislocation networks in high angle $YBa_2Cu_3O_7$ grain boundaries

- Equilibrium phase diagrams for the system PbO-CaO-CuO

- Oriented BSCCO thick film

coatings on polycrystalline MgO

- Carbon retention in $YBa_2Cu_3O_7$
- Lanthanum doping of $YBa_2Cu_3O_7$

Articles on infrared absorption, photoemission spectroscopy, electron tunneling, physical properties of $Ba_{1-x}K_xBiO_3$ SC's, magnetic phase diagram of high T_c SC's and electron doped high T_c copper oxide SC's can all be found in the June issue of MRS Bulletin.

The 1990 Fall Meeting of MRS (November 26 to December 1) in Boston will have a session called *Symposium H: Materials Issues In Application Of Ceramic Superconductors.* Those interested in presenting papers may contact MRS Headquarters; Abstracts expected by July 1 1990.

A carbon fiber reinforced tin composite superconductor has been developed by Deborah Chung of SUNY Buffalo, NY. The fiber reinforced composite sandwiches an YBCO superconductor showing a 26 fold improvement in tensile strength as well as improved resistance to thermal fatigue without lowering the T_c of 90°K and the current density. Contact Deborah Chung, Mechanical and Aerospace Engineering, 613 Furnas Hall, SUNY Buffalo, NY 14260; Tel 716-636-2520.

Another class of superconducting oxides, Li_xNbO_2 with a layered structure of very low T_c (5.5°K) is reported by Berkeley researchers (Nature Vol 345, May 24 1990, 324-325).

Meng et al., report the development of a process for making a bar of 123 compound with a size 5x0.5x0.3 cm with excellent grain alignment and a c.d. between $1.2x10^4$ and $3x10^4$ amp/cm^2. An oxygen sintered (24 hours at 940°C) bar is heated at 1100°C for a short time and is rapidly cooled to 1050°C to near the peritectic temperature to dissolve the impurities in the grain boundaries. This is followed by slow peritectic solidification. The bars are reoxygenated around 500°C for 24 to 48 hours. They feel that this approach is amenable to continuous processing of high T_c plates, rods, wires, ribbons, and thick films. (Nature Vol 345, 326-327.)

An interesting concept can be found in W.A. Fernando's article *'A Silver-Bearing High Temperature, Superconducting (HTS) Paint'*. (Bulletin #NSWC TR 90-48 Research and Technology Department, Naval Surface Warfare Center, White Oak Laboratory, 10901, New Hampshire Ave, Silver Spring, MD 20903, USA). If one can use such a paint on any substrate plastic or metal, myriads of opportunities open up in the race for power savings using superconductors.

A recent publication from Noyes Data Corporation is a book *'Applied Superconductivity'* authored by A.M. Wolsky and others of Argonne National Laboratory. The 365 page book costing $59 covers non-computing macro applications. It is available from Noyes Data Corporation, Mill Road at Grand Ave., Park Ridge, New Jersey 07656; Tel 201-391-8484.

Lo γ

In 1980 the Fusion Energy Foundation in Washington DC held a conference in collaboration with the *Executive Intelligence Review.* David

Goldman, the economics editor at that time and Dr Steven Baldwell, FEF Director of Plasma Physics were actively involved. The topic of the conference was Riemann-LaRouche economic model which looked at Thermodynamics of Economy. We wonder what FEF is planning for the 1990's ....

Some of the events at the National Cold Fusion Institute (NCFI), Utah look like the Politics of Thermodynamics! Early May announcements of donations to the tune of half a million dollars from an anonymous donor were denounced a month later. This gave rise to headlines such as *"External Fusion Funds Actually came from with U of U"* in local papers. This was followed by a editorial titled *"Latest Cold Fusion Stumble Gives Opportunity for Reassessment."* Apparently the donation was called anonymous for "intellectual, economic and strategic reasons." These confusions caused an uproar and audit by the State Fusion/ Energy Advisory Council which initially funded the startup of NCFI with five million dollars of state funds.

Adding insult to injury, media reported that three top laboratories which had earlier supported the Pons and Fleischman phenomenon, by finding tritium in the heavy water electrolysis, withdrew their claims of support after having found that the palladium cathodes were contaminated with tritium.

Such reports gives room for more speculation on the lines "how did the palladium get contaminated with tritium in the first place?" Two possibilities exist. [1] The palladium was previously used in the separation of Hydrogen isotopes; [2] Cast palladium contaminated with hydrogen (due to interaction of humidity with palladium while cooling) underwent a CNF transformation with aging, to leave tritium in the metal lattice. We at SHC contend that if the latter were true, all that is needed to cause a fusion reaction for useful extraction of energy is this: heat palladium and quench it in heavy hydrogen and hold at optimal temperature.

Science Magazine reports that Dr. Bockris of Texas A&M's support of CNF may be fraudulent. Apparently Dr. Bockris's electrolyte was spiked with tritiated water. However NCFI Director, Dr. F.Will stated that such reactions and reports do not necessarily preclude the possibility of cold nuclear fusion for "twenty-four laboratories world-wide had seen tritium in cold fusion experiments, which can be taken as evidence of duplication." He condemned the "middle ages attitude towards scientists." NCFI will be conducting double blind studies to test the cold fusion reports.

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Studies of Hi-T_c Superconductors A Book Review

A book titled *Studies of High Temperature Superconductors* edited by A. Narlikar, has been published by Nova Science Publishers, Inc., Commack, New York as part of its multi-volume publications in the field of superconductors, in 1989.

The first volume has articles written by twenty six scientists from six countries. In about fifteen chapters they review a variety of theories, practical approaches, and applications related to fundamental sciences. They quote more than a thousand references indicating the wealth of research in this field in less than three years since the pioneering discovery of high temperature superconductivity in mixed oxides, by Bednorz and Mueller (1986).

Glimpses of a few chapters are provided below:

Oxygen Hole Mechanism of superconductivity is reviewed by C.N.R Rao, Indian Institute of Science, Bangalore, India; emphasizing variable valence states of the cations and the two dimensional Cu-O states of cuprate super-conductors. No prediction of newer materials is made.

The role of chemistry in the synthesis of high T_c oxide superconductors in the Y-, Bi- and Tl systems is discussed by R.M Iyer and J.V Yakhmi, BARC, India. A brief review of solid state reaction and solution chemistry routes for bulk synthesis of various compounds, and techniques required in producing materials for high T_c's is provided. Their discussion of potassium substitution for Tl-2122 SC's, moisture effects in synthesis of different SC materials and some other synthetic chemistry problems will be of interest to synthesis hobbyists.

A chapter is devoted to *Substitutional Studies On High Temperature Superconductors* by A.V Narlikar, et al., NPL, India. The authors mention in conclusion that *substitutional studies hold the key of realizing phases with much higher T_c values than hitherto possible.*

The SHC agrees that this premise of empirical substitutions can lead to the development of higher T_c compounds. However, this chapter points out perennial difficulties in this approach without substantial clues as to what material would have the higher T_c's than the substitutes tested till now.

Electronically Driven Instabilities In High T_c Super-conductors and Related Materials by K Machida, Cornell University, includes a comparison of heavy Fermion superconductors of low T_c values ($CeCu_2Si_2$, UBe_{13}, UPt_3), copperless oxide SC's and the higher T_c rare earth- alkaline earth- cuprates.

The BCS pairing and possible mechanisms for high T_c SC by S.S.Jha, TIFR, Bombay, India, concludes that 'it is not surprising that we are still far away from the proper theoretical understanding of high T_c superconductivity', due to the lack of adequate experiments using single crystal data leading to other theoretical expressions for various physical quantities in the superconducting state. 'At this stage only, (after obtaining the additional information), we may be in a position to develop theories beyond BCS pairing model to describe the superconductivity in the newest anisotropic high T_c materials.

Carbotte and Marsiglio, McMaster University, Hamilton, Ontario, Canada, present the *Boson Exchange Mechanisms, Bounds and Asymptotic Limits* in conventional intermetallic superconductors as well as the oxide types. This chapter gives a detailed introduction to 'Eliashberg theory based on the calculation of the electron self-energy due to the emission and absorption of some boson. Eliashberg theory, an extension of BCS theory, has been, found useful in quantitative description of observed deviations from BCS in conventional superconductors', seems to create unexplained additional deviations in the anisotropic higher T_c superconductors.

Josef Rammer, University of Bayreuth, Bayreuth, West Germany, reviews *A Strong-Coupling Approach to High Temperature Superconductors*. He concludes that 'new concepts based on successful theories will be needed if we are to further enhance our understanding of the unusual properties observed.'

Yasuhiro Iye, University of Tokyo, indicates that the quasi-two dimensional character and short coherence lengths are added salient features of high T_c oxides unlike conventional superconductors, in introducing extensions to Ginzburg-Landau Theory which does little in treating *Fluctuation Effects and Flux Creep Phenomenon.* An attempt is made in explaining the differences of Fermi Velocity, υ_F, and the superconducting energy gap, ξ_o, calculatable by BCS theory. eg. Ordinary superconductors give $\upsilon_F \sim 10^8$ cm/sec and $\xi_o \sim 10^3$ to 10^4 Å, whereas for the HTSC's $\upsilon_F \sim 10^7$ cm/sec and $\xi_o \sim 10$ Å. [Note there is a minor typographical error in the Introduction paragraph of this article which notes Δ as the energy gap in one sentence and refers Δ as the T_c in the next. This confused the reviewer for a while].

Following above physico-quantum-electronic level theories a discussion on *The Role of Mott-Insulation, Non-stoichiometry and Altered Valence in High T_c Superconductivity* is reviewed by G.J.Hyland, University of Warwick, Coventry, UK. This article is well written and thought provoking in giving insight on the simplistic fundamental search of the Periodic Table in the race toward superconductors of higher T_c's. The author concludes that both electron-electron as well as electron-lattice interactions play a dominant role in determining the electronic structure of the normal phase out of which the superconducting phase evolves. He also feels that thorium might be suitable substituent for lanthanum. (This has partially been proven in the recent work done by other researchers).

On the experimental and application side, this volume contains the following articles.

° Use of one of the rare methods *Sound Velocity and Elastic Constants in Oxide Superconductors*, by R. Srinivasan, I.I.T., Madras, India.

° *Ion Beam Modification and Analysis of Thin $YBa_2Cu_3O_7$ Films*, by O.Meyer, Karlsruhe Institute of Nuclear Physics, FRG, includes effect of interactions with variety of substrate materials.

° *Basic Thin Film Processing For High T_c Superconductors*, by K. Wasa, et al, Matsushita Electrical Industrial Co. Ltd., Osaka, Japan, indicates that the layer by layer deposition is one of the most promising processes for a fine control of the superconducting phase of the rare earth free superconductors.

° *Twins in High T_c $YBa_2Cu_3O_7$ Super-conductors*, by C.J.Jou and Washburn, University of California, LLL, Berkeley, California, USA.

° *Three Terminal High T_c Superconducting Devices with large Current Gain*, by T.Kobayashi and U.Kabasawa, Osaka University, Osaka, Japan.

Essentially this first volume in the field of High Temperature Superconductors, by Nova Science Publishers attempts to encompass synthetic chemistry, speculations on theoretical models on why superconductors behave the way they do, information on some applications and fabrications of high T_c superconductors. This is a good overall reference book showing the initial developments in this field.

However, theoretical clues of what materials may have T_c's higher than known today are lacking in any of these chapters, which is not surprising as everyone has been trying to understand in a conventional surgical approach of cutting through *'holes'* and perceiving that the valence state of the cations have been dominant factors in giving the high T_c property. This is like if a pie can be made out of one fruit, other fruits can also be made into pies with the necessary same ingredients of pie crust, sugar and fruits cooked similarly.

SCUIPS

The Second World Congress on Superconductivity will be held on September 10-13, 1990 in the Four Seasons Hotel in Houston, Texas. Speakers from 15 nations are scheduled for presentations on various technical and business aspects of superconductivity including 'Space Applications' sessions. Those interested contact Cynthia King [713-957-1620].

MRS 1991 Spring Meeting will be held during April 29 - May 4, 1991 in Anaheim, California, USA. Symposium *P* will concentrate on 'Interfaces in High T_c SC systems'. Call for papers have been issued with an abstract deadline of December 1, 1990. Contact MRS Headquarters [412-367-3003 or 412-367-4373].

August 1990 issue of the Journal of Materials Research has six articles in the field of high T_c SC's.

Fourth Annual Conference on Superconductivity and Applications will be held during September 18-20, 1990, Buffalo, New York, by NYSIS. One of the conference highlights will be a 'US-Japan Workshop on Superconductors.' For more information please contact NYSIS at 716-636-3463. Plenary Session II will have an address by R.J. Cava, ATT-Bell Labs, on 'Looking for New High-T_c Superconductors'. It is hoped that this paper may provide more insight on this aspect than his article *'Superconductors beyond 1-2-3'*, which appeared in the recent Scientific American (August 1990).

R & D Magazine, August 1990, has an article *'Is US Vulnerable in HTS Race?'*. It is indicated that US topped the 1989 High T_c Research spending (about 130 million dollars). Most of this is Defense based funding to large corporations which may still preclude international competitiveness of commercial applications.

The book *'Chemical Synthesis of Advanced Ceramic Materials'*, by David Segal, Cambridge University Press, UK (published in 1989) includes discussion on ceramic synthesis including high T_c SC's. Methods discussed include sol-gel techniques, vapor deposition methods and hydrothermal routes among others.

Lo-γ

Very little news came out on the subject during the past two months. During the Gordon Conference in New London, New Hampshire, in July there were informal discussions on the Cold Nuclear Fusion Subject. Metallurgical Changes that can occur in palladium electrodes in heavy water electrolysis was presented by Dr. Sivaraman Guruswamy, University of Utah.

SC Wires & Fibers

J. Löhle, et al, of Lab. for Festkörperphysik, Zurich, Switzerland, describe *'Characteristics of high-temperature superconducting wires on the basis of* $YBa_2Cu_3O_x$*'* in their recent article in the J. Appl. Phys. vol 68(2), 15 July 1990 [pp 882-884].
More than 1000m long superconducting monocore and multicore wire fabrication using

the powder-in-tube technique with as high as 750 A/cm^2 superconducting transport current density is described in the article.

H. Nasu, et al, of Mie University and Showa Electric Wire and Cable Co. Ltd., Japan, discuss the 'Preparation of Bi-Sr-Ca-Cu-O High T_c Superconducting Fibers by Pyrolysis of Organic Acid Salts, in their recent article in the Jap. J. Appl. Physics, vol 29, No. 6, June 1990 [pp. L933- L935].

The technique involves mixing pre-sintered BiSrCaCuO powder with naphthenates of the cations [taken in the stoichiometric proportion] in toluene, forming a gel by reaction at 110°C in 24 hours, drawing the fibers, coating them with hydroxypropyl-cellose and heating them for 24 hours at 800 to 840°C in air. T_c of the fiber was 60°K with a tensile strength of about 7.5 MPa.

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Weak Superconductivity: A Book Review

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This fifth symposium had 27 papers on high T_c materials and 23 papers on conventional low T_c matter. The articles include synthesis and fabrication of thin films, device characterization, as well as theoretical models.

Techniques covered in the fabrication of thin superconducting films include methods such as DC Magnetron Sputtering, RF Magnetron Sputtering, laser ablation, nitrogen laser evaporation, vacuum coevaporation and ion beam patterning. The evaluations include the effect of different substrates.

For example, Lonekova, et al, Czechoslovakia, indicate that among the polycrystalline substrates used in making 2 micron films of YBCO, ZrO_2 gave a higher T_c film than $SrTiO_3$, MgO or Al_2O3, by DC Magnetron sputtering. J. Flokstra, et al, Netherlands, indicate that $SrTiO_3$ gave a higher T_c film than the one on MgO by using laser ablation. E.V. Ekimov, et al, USSR, discuss the polycrystalline film formation of MBCO [M = Y,Ho,Eu,Sm,Lu, or Gd] by magnetron and laser beam method on substrates of $BaTiO_3$, $LiNbO_3$ and sapphire covered with a layer of ZrO_2. V. Serbezov, et al, Bulgaria, describe their results on YBCO thin films by nitrogen laser evaporation and O_2 annealing using CW CO_2-laser. Besides testing substrates such as Al_2O_3, sapphire and $SrTiO_3$ they noted that deposition is possible on Silicon substrate although the T_c is lowered from about 87° to about 79°K. There are several more examples in the other articles. The fabrication of bismuth based high T_c films are discussed in the papers by P.Gierlowski, et al, Poland, Witold Kula et al, USSR and A. Plecenik, et al, Czechoslovakia.

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Several other articles on similar topics describe vortex pinning in high T_c SC's in bulk as well as thin film samples. Most of these discuss the origin of this aspect by the existence of internal Josephson Junctions around grains - grain boundary matter, etc. The studies were interpreting the nature of I - V curves with applied fields on the samples at different temperature below T_c onset.

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Volume 4 Issue 6 December 1990

Magnetic Superconductors

A Book Review

Magnetic Superconductors: Recent Developments, Nova Science Publishers, New York is dedicated to elucidating the interrelation between superconductivity and magnetism in the same system. The authors, K.P.Sinha and S.L.Kakani, point out that although the study of magnetic superconductors began more than two and a half decades ago, recent discovery of superconducting ternary and actinide compounds have renewed the interest in this field.

Novel superconducting phenomena resulting from the interaction of magnetic moments of f-electrons and superconducting electron (3d, 4d and 5d) are detailed in this book. They include: reentrant superconductivity, coexistence superconductivity and antimagnetism, magnetic field induced superconductivity (MIFS), and heavy fermion superconductivity.

The subject is well organized with an introductory chapter to magnetic superconductors followed by a survey of experimental results. A separate chapter describes each of the above phenomenon. The recently discovered high T_c phenomenon in various cuprates is covered in the final chapter.

The authors emphasize the difficulties encountered in studying the interplay between magnetism and superconductivity. Substitution of magnetic ions into superconductors either destroyed the superconductivity due to paramagnetic impurities or did not exhibit long range magnetic order. The new ternary compounds allow stoichiometric distribution of rare earth magnetic ions over periodic lattice sites allowing to overcome earlier experimental difficulties.

The second chapter, Survey of Experimental Results, is an excellent review of recent investigations. Several tables containing lists of various superconducting compounds along with T_c and original references will serve as a helpful resource for investigators in this field.

In each subsequent chapter existing models for each of the phenomenon are described. For example, the mechanisms proposed for high T_c superconductors, phononic mechanisms which include BCS coupling and electronic mechanism which include Little-Ginzburg exciton exchange, charge transfer exciton exchange, etc. are discussed. The authors also point out the general feature in all the theories as being the role of electron correlation in the superconducting phenomenon. They conclude that phononic mechanism is always present to a small measure while the electronic mechanism enhances the T_c considerably.

Although the book is aimed at scientists working in this field, it definitely fulfills its charter of being an excellent reference source of existing theoretical models and experimental results in the area of magnetic superconductors.
Reviewed by Dr. S. Elangovan

SCUIPS

A NIST and Westinghouse team of scientists have been awarded a patent on 'High-T_c superconducting unit having low contact surface resistivity and method of making' [U.S.Patent 4,963,523]. The technique involves protecting the superconductor contact zones from moisture and air degradation until a noble metal contact can be deposited. For licensing information contact Bruce Mattson, OTC, NIST [Tel:301-975-3084].

Mitsubishi, Tokyo, Japan received U.S.Patent 4,959,347 for the production of superconducting oxide precursors from mixed metal carboxylates coprecipitated by oxidation with ozone, hydrogen peroxide or benzoyl peroxide or other peroxyorganic compounds. This mixed coprecipitant is then formed and sintered in oxygen forming the superconducting ceramic.

Over one hundred papers on superconductivity in several sessions were presented in the November 1990 Fall meeting of Materials Research Society, in Boston, MA.

The high-T_c wire and ribbon developments were part of the highlights of The Applied Superconductivity Conference, Snowmass, CO [September 1990]. Sumitomos's silver-sheathed BSCCO 2223 was noted to exhibit 47 KA/cm^2 [including the effect of the parallel silver sheath conductor] at 77°K without external magnetic field, while American Superconductor reported observations of 10 KA/cm^2 at 15°K and several Teslas of field.

Pacific Superconductors, a division of General Atomics, announced the availability of upto 1000 meter long high T_c fibers and multi-filamentary wires. The wires cost $150/meter [minimum order 50 meters], while the fibers cost $50/ meter [minimum order 100 meters]. We at the SHC feel this lengthy achievement has been long overdue, and congratulate the event.

Why Not Other Compounds - A Note

Very little has been seen during 1990 about the newer compounds with higher T_c, excepting the recently announced controversial Sr-V-Tl-Oxides.

The following press clipping sent by one of our SHC members, is however intriguing until further literature details become available.

Kansas University physicist, Kai-Wai Wong announced in November 1990, about his discovery of a more refined structural model for high T_c oxide superconductors. This press release in the Lawrence Daily Journal, Lawrence, Kansas lacks scientific details, probably due to their filing of patent applications. The following are noted in the newspaper article. This is an extension of Dr.Wong's work dating back to 1968, the structural model helps in formulating SC oxides with accurate reproducibility, and apparently helps in the prediction of newer formulations. It is necessary that the formulations contain alkaline earth oxides (SHC wonders if this due to the need for forming stable peroxide ions in the structures), and the stabilized mixed oxide should behave as a semiconductor at room temperatures. Preliminary verifications by Wong's associates at the U of Arkansas and at the U of Hongkong were also noted.

Hopefully, Wong's structural model avoided simplistic calculations done by using generic XRD software which could lead to wild goose chase, as SHC had noted in their 1988 publication 'Peroxvite Theory'. As SHC gets more literature on this we will keep our readers informed. It is also surprising that this information has not yet been noted in the bibliographic High-T_c Update, published from Ames, Iowa.

Neale R. Neelameggham

SEASONS GREETINGS TO ALL

Starting 1991 Lets Levitate will be published as a Quarterly.